

On Fundamentals of a Moving Particle in Space

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Abstract *Motion* is the elixir of life, both for the animate and the inanimate. Everything that we may conceive, observe and measure, that causes a change of the system we are in and with the environment around us, is due to *motion* that takes place in *space* over *time*. In addition, matter is created and endured also due to *motion* of its constituent parts, and all changes in matter in terms of its structure, property and relative position in *space* are caused by *motion* of its constituent parts among them and, as applicable, with the surrounding environment interacting with it. Matter is composed of particles which have minimum finite and discrete existence in view of *motion* undertaken by them and so quantization of our universe follows as an essential feature. *Motion* results in *action* causing transfer of *momentum* and *energy*, all of which must therefore be quantized, since there must also exist a minimum value of *action*. Matter is composed of *space* and *energy* only and *mass* of an *elementary particle* arises out of its *intrinsic spin angular momentum* and *angular frequency*. *Particles* and *fields* are of conjugal nature and while there is only a *common field* in *space*, the specific nature of a *field* is determined by the *particles* that are coming on to play on the *field*. Study of *motion of a moving particle in space*, therefore, elicits the complete knowledge about our universe.

Keywords Space, Time, Motion

1. Introduction

This article has been based on the physical concept of motion and its insinuation on the interaction between matter and space. Through intuitive reasoning and conceptual considerations rather than any analytical or mathematical approach, an attempt has been made to characterize motion of an elementary particle in space over time, and how this simple yet profound conception may be inter-related to every other phenomenon in this universe. It has been conjectured primarily by means of logic how the quantum physical concept of motion of a fundamental particle may elucidate physical quantities and properties e.g. mass, momentum, energy, quantum field, gravitation, wave-particle duality and so on while the same notion may be extrapolated to the realm of general relativity and to the universe in its entirety.

2. Space, Time and Motion

2.1. Space and Motion

Space is the source of everything in our universe. This is a fundamental truth and so all our queries as well as their answers need be directed at it. On the other hand, *motion* [1] is fundamental for everything that happens or causes to happen in our universe. I will conceive *motion* as a change of position or configuration that takes place inside *space* over

time and every *motion* may only be relative with respect to a reference in *space*. During *motion* positions overlap making it continuous but the *object* undergoing *motion* withdraws completely from an initial to a final position. So an *object* must always be discrete and finite whereas *space* must be continuous and non-discrete allowing *motion* to take place inside *space* which in turn cannot have any internal structure and cannot undertake *motion*.

As an aside, while by *object* I may mean an everyday matter object, *motion* may be undertaken by and the same concepts are applicable with an individual *particle* [1], a composite of particles or a *system* of particles with an arbitrarily chosen boundary separating it from the environment surrounding it. Hereinafter, instead of object I will use the terms *particle* and *system*, freely, as and when applicable.

2.2. Time

Time has a *space* equivalent relationship with *motion*. Both *space* and *time* do similar things e.g. Record the start and end of *motion* and measure the *change* and *duration* by and over *space* and *time* through a recurring measure of the same using a unit of scale by means of successive *motion*. It is this *change* or *duration* that relates *space* and *time* with *motion*. Thus there cannot be any duration of *time* without change of *space* and there cannot be a change of *space* without duration of *time* both being caused by *motion*. Therefore, a measurement of *time* is only made possible by measuring the frequency of a repetitive change of *space* due to a periodic *motion*. In the same way a measurement of *space* is made possible by a repetitive measurement of the

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Published online at <http://journal.sapub.org/ijtmp>

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change of position due to *motion* over *time*. The above universality due to the harmony and inter-relationship among *space*, *time* and *motion* is the most basic and fundamental concept in our universe.

2.3. Discreteness and Quantization

Every other physical quantity can be specified in terms of *space* and *time* along with *motion* and other applicable specific properties, since a physical quantity attributes a change and needs a measurement which is possible only due to *motion* in *space* over *time*. Any physical quantity that is discrete and finite must have a minimum value and since every larger value of it can exist only as an integral multiple of the minimum, the physical quantity must be *quantized* [1]. Thus quantization is an essential need instead of a surprise and it arises from the aforementioned relationship of *space*, *time* and *motion*. However, in terms of a unit of measurement, when the unit value is taken other than the above minimum, a physical quantity may appear un-quantized, while quantization in our universe is an indispensable feature of a physical quantity irrespective of its nature.

Some physical quantities are considered explicitly quantized, in the sense that they exist and change their values from one set to another, only as integral multiples of a quantum value. I will say this is also an intrinsic feature since the creation as well as the change of value of the physical quantity arises out of its state of *motion* causing the result as an *action* due to *motion*, which is having a minimum value too.

Moreover, any physical quantity being finite must also have a maximum value and be expressed as a relationship between finite quantities. By definition, *speed* of a particle is measured as a finite amount of *space* traversed over a finite interval of *time* and so it must be finite having a maximum value.

Expressed analytically, *speed* is the product of the finite *circumference* of a circle having a finite *radius* and the finite value of the simulated *revolution per unit time* caused by the *motion* of the particle.

$$v = \omega * r = (2\pi n) * r = (2\pi r) * n$$

Symbols:

v = Speed, w = Angular frequency, n = Revolution per unit time and r = Radius.

For the same reason, speed of light(c) must be finite having a maximum value.

2.4. Particle only in Motion

Every particle in our universe must always be in continuous *motion* moving from one state of *motion* into another state in terms of position and other attributes. This fact will be more evident and revealed as truly relevant from my further discussions below. In addition, it is a *particle* or a system of particles only that is capable of undertaking *motion* in *space*, there is nothing else that can undergo *motion*.

3. Action and Interaction

Every *motion*, at the end of its duration, results into an *action* [1] causing the system undergoing *motion* to move into another state of *motion*. Thus while *motion* is continuous, an *action* may be worked out of it as the end result of *motion* from an initial space-time combine of the system into a final one, for the arbitrarily chosen space-time interval.

This also means that an *action*, as the outcome of *motion*, must have a discrete and finite value, which will in turn make *action* as a quantized physical quantity and having a finite minimum value, as it has already been measured by the value of the Planck constant (h).

Since *motion* is a spectacle which is caused upon the system, it must be the outcome of an *interaction* [1] [2] between the system undergoing *motion* and any other system external to it. In other words, there must be a reason for *motion* to happen, and that is what an *interaction* provides for.

On the other hand, as *motion* is undertaken by a particle or a system of particles only, an *interaction* between two particles or systems, must also be caused by particles only, moving from one space-time combine into another. I will discuss this aspect at length later.

4. Energy and Momentum

Energy [1] is what changes a system from one state of *motion* into another and it manifests only in transit between one system and another. Since transfer of *energy* causes the change of the state of *motion*, a system should be considered at a higher level of *energy* when it receives additional *energy* from an exogenous source which is also another system external to it.

Similarly, a system will have a lower level of *energy* when it releases *energy* out of it causing it to move to a lower state of *motion*. This concept conveniently allows a system to be given a number quantifying and measuring its *energy* level only, and by no means is the system deemed to possess any *energy*. The total value of the measure of *energy* of a system has been divided into *kinetic energy*, *potential energy* and *rest mass energy*.

As *energy* manifests itself in transit and can only be transmitted piggyback by particles in *motion*, being in discrete and finite amounts, *energy* must also be quantized. There is also another way of looking into this. Since transfer of *energy* results into *action*, which is quantized, *energy* must also be quantized.

Expressed analytically, *action* is proportional to the product of *energy* transmitted and the *time* interval for the duration of the transfer.

$$\text{Action} \propto \text{Energy} * \text{Time}$$

This will also allow simulating *energy* as a *time rate of action*.

$$\text{Energy} \propto \text{Action} \div \text{Time}$$

Any change is caused by *motion* which has magnitude as well as direction and so it must be related to a vector bringing up the change over *space* and *time*. This results into conceptualizing another physical quantity which is called *momentum* [1]. Since a particle only undertakes *motion*, it must carry *momentum* along with it while transferring *energy* from the initial space-time combine to the final one. Also in a similar way, *momentum* may be simulated as a *space rate of action*.

$$\text{Momentum} \propto \text{Action} \div \text{Space}$$

The *Uncertainty Principle* [1] therefore, directly ensues from the above analysis; since *action* is finite as the end result of any *motion*, the same may be attained by any given combination of *energy* and *time* or *momentum* and *space*. A more physical approach with *quantum state of elementary particle* [1] will follow.

Moreover, the particle under going *motion* should manifest a property in addition to speed allowing it to carry *momentum*, which is conceived as *mass* of the particle. So it is because of having *mass* a particle is able to carry *momentum* while it is in *motion*.

Every scalar needs a vector to cause a change of its value through some kind of *motion*, which also means transfer of *energy* and *momentum*.

5. Elementary Particle

An everyday object is composed of matter having definitive material properties including its size; and there are innumerable such objects with many diverse properties. If an object is fragmented into smaller pieces, they will still retain its essential material properties but now will endorse the fact that the larger object was composed of smaller ones of the same matter. If in the same way the object is broken into still smaller and smaller pieces, there must be a limiting size and content, which is already known as the molecule. Moreover, it is also known that the molecule is further composed of still smaller particles called atoms and finally an atom is also a composite of still smaller particles, down to the ones called *elementary particles* [2], which have limiting existence by virtue of their being particles yet not composites.

Thus *elementary particles* of matter are logical consequences as above. Moreover, it should also be logical and rational, taking a cue from identical building blocks used by children to make toys, to comprehend that *elementary particles* must be of a few varieties only and all particles of a specific variety must be indistinguishable and finally all composite particles and larger matter objects in our universe are made out of them by various permutation and combination only. Both theoretical and experimental results already support this fact.

In a similar manner, it can be conceived that *elementary particles* must be born out of same inputs and by the similar process, with needed variations to produce them, otherwise too many different inputs and processes would be needed, a fact which is unrealistic and wanting too.

However, the only known inputs available in our universe are *space* and *energy* and so I will arrive at the following simple generic relationship:

$$\text{Matter} = \text{Space} + \text{Energy}$$

This means that an amount of *energy* can enter into a certain volume of *space* thereby converting *space* into *matter*. Also this *action* suggests that the resulting *space-turned-matter* must have a discrete finite existence being of an extended version unlike a point. An *elementary particle* is created in this way out of *space* by means of *energy*, and then it may go on to make composite particles in association with other elementary particles, and thereafter larger matter objects are formed. A reverse process may occur as and when particles disintegrate through decaying, nuclear fission, fusion and annihilation. After the particle disintegrates, *energy* is released and *space* occupied is returned to the environment, as only partially, obeying the principle of conservation of mass and energy, before and after the due process.

6. Mass of an Elementary Particle

Mass [1] [2] is an intrinsic property of an *elementary particle* making it distinguished out of *space* and giving it the character of a discrete finite particle which is only capable of undertaking *motion* carrying *energy* and *momentum*. Such a conversion of *space* into *matter* would be possible only if that *space* assumes a special feature, much akin to a spinning top which offers resistance to toppling while falling down as if massless when not spinning.

I will consider this special feature as having an intrinsic *angular momentum* and *angular frequency* [1] [2] which together become equivalent to the amount of the contributing *energy*. The *angular momentum*, even if cannot be detected, has a measured component projected along an axis, and so it may be considered as equivalent of a *mass*, *angular frequency* and an *intrinsic linear dimension*. The particle so created cannot be a point like with no real existence but must have an extended version occupying a finite, although variable, amount of *space*.

The *space* so occupied will have an intrinsic *capacitance* (*C*) and *inductance* (*L*) related to an *angular frequency* (ω) and an *intrinsic linear dimension* (*r*). Since *energy* can manifest only in transit, the above amount of *energy* will have to undergo an oscillatory transition between electric and magnetic energy similar to a resistance-free LC circuit thereby perpetually in transition without loss of energy along with the above *angular frequency* (ω). This results in creating the property of an intrinsic *mass* for the *elementary particle*.

Expressed analytically, the relationships are shown in the following.

$$C = \varepsilon * r$$

$$L = \mu * r$$

$$\omega = 1/\sqrt{LC} = c/r$$

$$S = m * r^2 * \omega$$

$$E = S * \omega = mc^2$$

Symbols:

C = Capacitance, L = Inductance, ϵ = Electric constant, μ = Magnetic constant,

r = Intrinsic linear dimension, ω = Angular frequency, c = Speed of light,

S = Spin angular momentum, m = Mass and E = Rest mass energy.

Unlike the rotational kinetic energy due to conventional angular momentum of a particle at the end of a radial arm with an existing mass, the equivalence of the rest mass energy of the elementary particle, having no mass to start with, provides the intrinsic spin angular momentum associated with an angular frequency corresponding to the oscillating LC circuit by virtue of which the space acquires the property of a mass turning into a particle at rest and becoming able to carrying energy and momentum when set in motion due to an exogenous interaction thereafter.

Spin angular momentum of an elementary particle has been accepted as an intrinsic property of it while its origin and cause of inception are not yet vindicated by any theory or experimental result.

Likewise I have not made any attempt herein to furnish any proof of its foundation logically or philosophically, however, accepting its paramount existence, I have only made use of its potential derived effect on the other intrinsic property of an elementary particle e.g. mass, along with the angular frequency and the intrinsic linear dimension which may provide the extended version of the elementary particle as against its supposedly point occurrence only.

Moreover, this intrinsic angular momentum has been deemed not as the classical one, produced by the application of an external torque. It is considered as equivalent of the rest mass energy which is the source of it along with the angular frequency, originating from the oscillating electric and magnetic energy stored in the space causing the massive particle to be produced.

Mass of an elementary particle is not due to some other particle or substance added to it from an external field but it is an intrinsic property arising out of its spin angular momentum while the particle is never conceived as a conventional spinning object in space, yet manifesting all the attributes to be associated with the concepts of mass, angular frequency and linear dimension, independent of each other, and together as the angular momentum, being the outcome of the rest mass energy of the particle so produced.

An electrical charge has its origin as an excitation of the quantum physical field, irrespective of the nature of the particle causing the field, whereas the direction and symmetry of the excitation result in a positive, negative or neutral charge, and the same way both matter and anti-matter may be produced.

When the excitation is large enough, the equivalent amount of energy causes an extended version of space at its location to be converted into a storehouse for an oscillating

resistance-free LC circuit to be perpetually in transitory motion, which is the source of the intrinsic spin angular momentum of the particle that causes the particle to have the property of mass.

The elementary particle with an electric charge, or for that reason any matter or anti-matter, so produced will always be generated in isolation, and not in pair, but only as an individual particle. While the probability correctly predicts generation of equal and opposite particles in the overall long run, there is also the probability of generation of identical particles over an extended tenure. Since this is not forbidden, it will become mandatory and so there will be an excess of a particular type of particles over the very long period of existence of the universe.

Therefore, there are more particles of a particular nature e.g. matter particles in occurrence in the universe causing matter objects to be formed.

Furthermore, additional analytical relationships may be found among the above intrinsic properties of an elementary particle with the amount of electric charge corresponding to the electric or magnetic energy equivalent of the rest mass energy of the particle, for the Bose-particle and the Fermi-particle [1] [2] [3].

$$E = S * \omega = m * c^2$$

$$E = q^2 / 2C = q^2 / (2\epsilon r)$$

$$q = k * e$$

$$\alpha = e^2 / (4\pi\epsilon\hbar c)$$

$$k^2 = S / (2\pi\hbar\alpha)$$

$$m * r = S / c$$

$$m / \omega = S / c^2$$

$$q_b = 6e$$

$$q_f = 5e$$

Symbols:

q = Electric charge, q_b = Electric charge for Bose-particle, q_f = Electric charge for Fermi-particle,

e = Electron charge, \hbar = Reduced Planck constant, α = Fine structure constant

and k = Multiple of electron charge.

The above relations indicate the following features, for both Bose-particles and Fermi-particles:

- Product of mass (m) and intrinsic linear dimension (r) is a constant
- Ratio of mass (m) over angular frequency (ω) is a constant
- Electric charge equivalent to the rest mass energy is a constant

So each *elementary particle* of the same class enfolds the same *electric charge*, however, the *mass* of the particle will depend on the *angular frequency*; and higher the *angular frequency* higher will be the *mass* of the particle. This explains why particles of higher *mass* are unstable and tend to decay into particles with lower *mass* and *angular frequency*. Moreover, since volume occupied by the *space* is proportional to the third power of the *intrinsic linear*

dimension, the *energy-density* will be inversely proportional to the fourth power, thus making it too sensitive to the linear dimension and frequency. This further implies that an *elementary particle* must have a *mass*, however small, and an *intrinsic spin angular momentum* causing it. So a *photon* cannot be considered massless, while depending on its kinetic energy due to *motion*, the *rest mass energy* will appear as a tiny part of its *total energy*.

7. Motion of an Elementary Particle

Consider an *elementary particle* in *space* at rest, while it is capable of undertaking *motion* in any possible direction. In absence of any other particle in the environment surrounding it there will be no *interaction* with another particle, so it will continue to remain at rest, and there shall be no relevance as to *time*, since *time* will cease to exist without *motion*. We may discard such a scenario.

Now let the particle of *mass* (m) be in *motion* with a velocity (v) moving in a particular direction and let us analyze the steps that will follow. The particle will have *total energy* (γmc^2) inclusive of its *rest mass energy* (mc^2). Over a *time* (Δt) the particle will move to a new position occupying a new *space* and leaving the earlier *space*. So it will interchange the earlier *space* with its environment. It will do so by interchanging an amount of energy equivalent of its *rest mass energy* (mc^2) with the environment. That means the particle will occupy the new *space* with its *total energy* (γmc^2) and the earlier *space* will be exchanged with the new *space* having equivalent *rest mass energy* (mc^2). So the *energy balance* will be restored and there will be no violation. We may say the new *space* was occupied by a *virtual particle* [2] [3] which has the same *rest mass energy* as the *particle*. It also means a *virtual particle* exists in the immediate vicinity of the *particle* allowing it to do the above interchange making *motion of the particle* possible. In reality, the *virtual particle* may also have a *momentum* of its own, but that will be independent of the above interchange in view of the *principle of superposition* [2] [3].

We will do a simple analytical exercise for the above interchange by considering the following.

ΔT_1 = Time measured in particle's frame of reference

ΔT_2 = Time measured in virtual particle's frame

γ = Lorentz factor

$\gamma mc^2 / \Delta T_1$ = Rate of exchange of energy = $mc^2 / \Delta T_2$

$\gamma mc^2 * \Delta T_2 \propto$ Action taken place $\propto mc^2 * \Delta T_1$

$\Delta T_1 = \gamma * \Delta T_2$

ΔL_1 = Space measured in particle's frame of reference

ΔL_2 = Space measured in virtual particle's frame

$\gamma mc^2 / \Delta L_2$ = Strength of interaction in between = $mc^2 / \Delta L_1$

$\Delta L_1 = \Delta L_2 / \gamma$

This shows the effects of *time dilation* and *length contraction* due to *relativity of motion* between the *particle* and the *virtual particle*. So the *particle* will continue to

undertake *motion* by following a similar interchange with another *virtual particle*. However, since the *particle* is free to move in every possible direction, there will be a number of *virtual particles* around it in its immediate vicinity, ready to interchange position with it, as also during its *motion* there will be continuous interchange with *virtual particles*, in all probability at random only, keeping in view the overall direction of *motion* and not much deviating from the general straight path, in absence of any other exogenous interaction with the particle. This will result in a *quantum state of motion* as is envisaged in the real world, much akin to random movement of an individual in a crowd by exchanging his position with another person while maintaining direction towards his true destination.

8. Particle and Wave

The above analysis of *motion* of an *elementary particle* shows that the *particle* will travel along with other *virtual particles* around it, and each such *virtual particle* in turn will behave like the *particle* ready to interchange its position with another *virtual particle* in its own vicinity. The same scenario will be at every instantaneous position of the *particle* in *space* which will result in the formation of a *plane wave* pattern out of the sea of *virtual particles* moving along with the *particle*. So a *wave nature* of the particle will be observed during its transition from an initial to a final space-time combine. This explains the *wave-particle dual nature* [1] [2] [3] of an *elementary particle* in *motion*.

One consequence of the above *motion* of the *particle* will be *interference of waves* [1] [2] after it is allowed to pass through dual slits, as has been observed by experiments. However, in case the *particle* is held *under observation* by an external agency, its path will be *visibly tracked*, instead of its overall random motion interchanging its position with *virtual particles*, and so the *interference* will break down. Even for a *single particle dual slit* or *single particle wide-angle version* experiment, the same effect will be observed due to the above *quantum state of motion* of the *particle* allowing a *wave-particle duality*.

In analytical terms, the above behavior has already been closely simulated by employing probability concepts and working out the relevant relativistic equations of motion. Herein I have provided an explanation for the reason for such a behavior, as has been critically observed by various experiments.

9. Particle and Field

An *elementary particle*, in view of its impending *motion*, in any or every possible direction around it will generate a sea of *virtual particles*, ready to interchange positions in conformity with the random motion of the particle while keeping the overall general direction of motion as straight as may be allowed.

As a result there will be a *virtual field* [1] [3] created around the particle, with each virtual particle at every point in space around the particle providing for the field location and property. Moreover, a virtual string of influence may be traced starting from the particle along the row of virtual particles forming the string, causing the birth of the line of interaction akin to the conventional lines of force.

In case of any other particle present in the immediate vicinity away from the particle in consideration, there will be mutual interaction between the two and the above lines of interaction will be stretched along the intervening space and terminated at each other.

Since a particle will have several characteristic properties e.g. mass, electric charge, momentum, energy etc. the nature and extent of *interaction* between the two particles as above will depend on these characteristics. This means that a particle in *motion* has its ability to exercise its influence at another position in space away from it and in case of another particle located at that position, there will be *mutual interaction*, following the principle of superposition, the original individual influence of each particle being strictly independent only.

The overall effect of the above is the *creation and sustenance of a field* [2] [3] in the intervening space; the strength of the field varying over distance and the particles will undertake motion in association with the fields too. The interaction between the particles, as earlier pointed out, can only be effected by interchange of virtual particles along the lines of interaction, as particles only may carry the influence by virtue of their having mass and thus being able to carry and convey energy and momentum needed to effect the change.

In addition, for particles having electric charge, magnetic potential and so on, real particles in the form of photons will be radiated by the particles creating the field and carrying out the interaction. The actual nature of the field will depend on the nature of the particles brought into play on the field. So in effect, *space is the unified field* [2] [3] [4] [5] where every interaction takes place depending on the particle coming into interaction.

Matter particles will create gravitational field and interaction, charged particles the electromagnetic interaction and weak and strong interactions will be effected by the relevant particles. This is much the same way as the players coming on to play may decide if the same field is going to be turned into soccer or rugby or a hockey field.

However, an eternal unanswered query will endure as to which comes first, the particle or the field. Same way you shall never know if it is your own thinking or listening to another one started your own thinking and talking, as you continue to practice since inception.

10. Ground State and Vacuum Energy

The *motion* of an *elementary particle* in relation to the *field* implies an important fact that the *space* surrounding the

particle provides a *store house of energy* from which the *virtual particle* is created and the interchange of energy and position takes place allowing *motion* to transpire. This happens to be the *ground state* with *vacuum energy* [2] [3] firmly postulated by Quantum field theory (QFT) [4] [5] [6] featuring a paradigm of an oscillating mass at the end of a spring to account for the same.

Since energy manifests only during transit I will look at it in a different way.

The *elementary particle*, in view of its impending *motion*, draws out an amount of energy equivalent of its rest mass energy (mc^2) out of the ground state of the surrounding space creating the virtual particle. Once it is done, the laws of conservation of mass and energy come into play, and all along the account is balanced before and after each transaction that takes place obeying the principle of conservation. In this sense, *energy is created out of the ground state* by the *motion of the elementary particle* and then the energy balance persists.

This is like taking out a bucketful of water from the ocean and then you may convert it partly into ice or steam or turn into a solution; still you may continue to keep a tab on the total quantity and account for it by way of conservation of mass, not creating or destroying any more.

The mystery of nature, how and wherefrom comes this vast energy of the ground state, however, will persist, for the present, as science, not theology, is yet to find an answer to this profound query.

11. Gravitational Interaction

Gravitational interaction [3][6] exists between two or more massive particles, solely in view of their having the property of mass. As indicated above, a moving particle will interchange its position with virtual particles around it thereby creating a field. Since in this way the particle can only interchange an amount of energy equivalent to its rest mass energy, the strength of gravitational interaction will be related to the mass of the particle. In case of two massive particles in the vicinity of each other, a gravitational field will be so created and gravitational lines of interaction will be originating and terminating between the particles. Other properties related to the mass of the particle e.g. momentum and energy will also be brought into play in the gravitational field intervening the two particles resulting in mutual attraction.

This aspect has already been depicted by the theoretical analysis of the Quantum field theory (QFT), whereas the General theory of relativity (GR) accounts for very large massive bodies only.

In case of a system of particles closely held together forming a large body with a big mass, there will be an enormous sea of virtual particles surrounding it and the same will be subjected to stress and strain as have been incorporated in the formulation of the equations of GR, resulting in formation of curvature of the space-time fabric

as has been stipulated by the theory. I will postulate it in this way only connecting GR with QFT saying that both are partially correct in their respective domains, while having a causal relationship between the two as indicated herein. So QFT provides for the source of the features adopted in the GR complementing each other in establishing a complete rationale behind gravitation.

The principle of relativity says laws of physics are the same in all inertial frames of reference while observations and so measurements do vary. In special theory of relativity, in absence of an external gravitational field, the difference is due to constancy of the speed of light. In general theory, in presence of a gravitational field, the difference arises due to dependency of the speed of light on the gravitational potential and the prevalence of mass-energy-momentum of the gravitating masses causing curvature of the space-time to be followed by the massive particle whose motion is under observation.

As motion causes and follows the space-time events, the particle under motion will follow the path of the space-time co-ordinates, by exchanging its position with the string of virtual particles, set in by the mass-energy-momentum of the gravitational field in the same way as I explained in Article 7. This will be an inertial motion in its own frame of reference, but it will be observed from any other frame as an accelerating motion independent of its mass, as has been vindicated by GR, which is considered as the motion along a geodesic in a curved space-time only. Since the overall massive object is a composite of such individual particles, the overall motion of the body will be observed accordingly.

12. Electromagnetic, Strong and Weak Interaction

Particles having electric charge or magnetic potentials will generate photons as equivalent of massive particles which will create the electromagnetic field resulting in the corresponding interaction. This theory has been widely and firmly established with adequate accuracy to be considered tenable already. Moreover, QFT does account for the experimental observations of electromagnetic interactions fully. Similarly, both strong and weak interactions are effected by the interchange of respective mediating particles as has been vindicated by the corresponding theories underlined by the QFT too.

13. Matter and Universe

We live in *space*. This is our *universe*. We find *space* around every *matter* object, in between *matter* objects and within *matter* too. So essentially universe comprises of *matter* and *space* only, as we have postulated earlier that *matter* is also created out of *space* by *energy*.

Moreover, *matter* is composed of *particles*, and starting with the *elementary particles* which together make composites which are then bound or closely held together to

form *matter* objects, *matter* appears in various physical states e.g. solid, liquid or gaseous. The composition, appearance, color and many other properties attributed to *matter* objects depend on how the constituent particles are held together in close proximity giving rise to such various properties. On further close scrutiny we find that it is *motion* of the constituent parts, which makes this happen as we also know the constituents are in continuous *motion* in relation to one another.

To start with, we have a few elementary particles, as indicated earlier, broadly classified as follows.

- *Bose-particles* undertaking mediatory roles for causing *interaction* between particles
- *Fermi-particles* undergoing *motion* in order to be held closely together to form *matter*

So we have two primary functions of *elementary particles* as noted above. Moreover, such functions are performed by the *motion* of the particles only which can be classified as under.

- *Translatory motion* either as forward or backward
- *Rotational motion* either clockwise or anticlockwise

In order that *matter* is formed, particles need to undergo *motion* as above, in suitable combination, irrespective of the paths or trajectories they may follow and at the same time should remain in close proximity of one another. For *translatory motion* this becomes possible in terms of *oscillation* and *vibration* around a neutral position. For *rotational motion*, it can be either *orbital motion* around a center or *spinning* around an axis.

The multiple shell structures of atoms, with orbiting electrons, provide a solution as above forming the overall configuration of atoms which are then bound together to form molecules which again in various combinations form matter objects, all by suitable combination of the above kinds of motion, in addition with the provision of mediating particles, as and when applicable.

However, it becomes far more complicated when particles need be together at one location only to form a center, as is needed to constitute the *nucleus* of an atom. While the constituent particles of a *nucleus* must be held very closely together, they still must also be in perpetual motion among them. So there arises a special kind of motion e.g. *asymptotic freedom* [3] which allows particles to move or float nearly freely while they are close with one another, yet they cannot move afar as they will then be pulled back to proximity once more, the latter action being made possible by other mediating particles.

So far I have refrained from coming up with a precise definition of *space*, since no amount of necessary and sufficient words can do so. However, by way of discussions till now I have presented several facts which have already been vindicated theoretically and through experimental observations, and some new postulates, which together form an understanding about the nature of *space*.

While *space* is neither a container for matter nor an intervening vacuity devoid of matter, it is equally an

all-encompassing entity of which matter is an integral and conjugal part staying in harmony with a *field* surrounding matter and created by its *motion* in *space*. The shape, size and the boundary of a matter object, however large or small it is, may be observed by us since we may look at it from being outside of it and not being inside it. Whereas since we are destined to live as confined within space, whatever speculation we may make and irrespective of those conjectures being near truth or not, we shall never be able to escape out of *space* and so shall not be in a position to observe the shape, size or the existence of a boundary of space. As we travel away in *space*, *motion* will create more *space* ahead of us and other matter objects will interact with us, and we shall ever continue to remain inside *space* only. The distinction between the *micro* and the *macro* world is solely arbitrary, as the fundamental principles are the same ruling them both, and the realm of the grander universe is formed out of *superposition* of the *quantum* world of the *elementary particles* and their prime *motion* carrying *energy* and *momentum*.

14. Conclusions

I have drawn this treatise to present the fundamental concepts and principles governing the *motion* of *particles* in *space* which is the primary cause of formation and continuation of our universe. Based on a conceptual rather

than an analytical approach I have endeavored to look into the conduct of *elementary particles* under interactions which, following the correspondence principle, rules the behavior of everyday objects while ranging both ways to the nano world and to the sphere of heavenly bodies in deep space. I do firmly believe that the *macro rises out of the micro domain* alone and that *motion is the elixir of life* for both the animate and the inanimate.

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